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Malaria Control in War Areas
FIELD BULLETIN



HABITS AND CHARACTERISTICS OF THE MORE
IMPORTANT ECTOPARASITES OF RATS

ATLANTA, GEORGIA

OCTOBER - NOVEMBER - DECEMBER, 1945

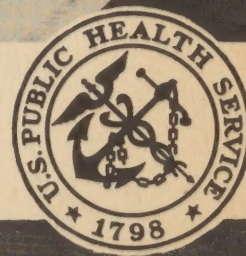


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HABITS AND CHARACTERISTICS OF THE MORE IMPORTANT ECTOPARASITES OF RATS

By P. A. Sanitarian (R) Charles E. Gerhardt

In the control of arthropod-borne diseases, a basic knowledge of the carriers or vectors involved is essential for intelligent application and appraisal of control measures. This discussion deals with some of the salient features of the habits of ectoparasites found most commonly on rats, and describes characters used in identifying the more important species. Life cycles are also described and host parasite relationships explained. This information is supplied with particular reference to the use of DDT dust in the control of murine typhus fever.

ECTOPARASITISM OF DOMESTIC RATS IN GENERAL. The parasitic habit in animals has developed from successive adaptations of species which have established a convenient existence on or in other animals. The association is primarily a food relationship. Ectoparasites probably evolved first among predaceous feeders, scavengers, or other animals with sucking mouth parts. Parasites affect their hosts in varying degrees. In some instances the host is actually benefited. In a few cases an animal is unable to live without its parasites. At the other extreme, some parasites may cause the death of their hosts. The ideal host-parasite relationship exists when the host is unharmed and the parasite is able to complete a normal life cycle.

Modifications in body form are characteristically found in parasites. In general, these animals are more highly specialized than their free-living relatives. For example, the dorso-ventral flattening of ticks permits them to stick close against the host. Fleas, which move about actively between the hairs of the host, are compressed laterally. Lice and mites, which are ectoparasitic on do-

mestic rats, are well suited to their host because of their small size.

CHARACTERISTICS OF FLEAS. Fleas are insects belonging to the order *Siphonaptera*. They are temporary ectoparasites of warm blooded animals. Both sexes feed on the blood of their hosts. The body of a flea is compressed laterally, and sclerotized very heavily giving it a smooth hard surface. These adaptations enable the insect to move readily through the hairs or fur of its host and resist crushing. Wings are absent. Eyes may be present or absent but are simple when present. The mouth parts are adapted for piercing and sucking. Sexes may be distinguished by the presence of a heavily sclerotized spermatheca (receptaculum seminis) in the posterior part of the female abdomen, and by the very complex, coil-like genitalia of the male. (See Figs. 1 and 2.) In their development, fleas undergo complete metamorphosis or changes as described subsequently.

Eggs may be laid either on or off the host. When laid on the host, the eggs soon fall or are shaken into the nests or places frequented by the host. The eggs hatch into active, legless, eyeless larvae with slender bodies of a yellowish or whitish color. Flea larvae are not parasites, but live on organic debris. Larvae of some species use the excreta of the adult fleas for food. When mature, the larva spins a silken, almost transparent cocoon and changes to a pupa. After a period of quiescence, the adult emerges. The length of time spent in each of the developmental stages and as an adult flea varies widely according to temperature, humidity, availability of suitable food, and individual responses of the species.

Although fleas are comparatively

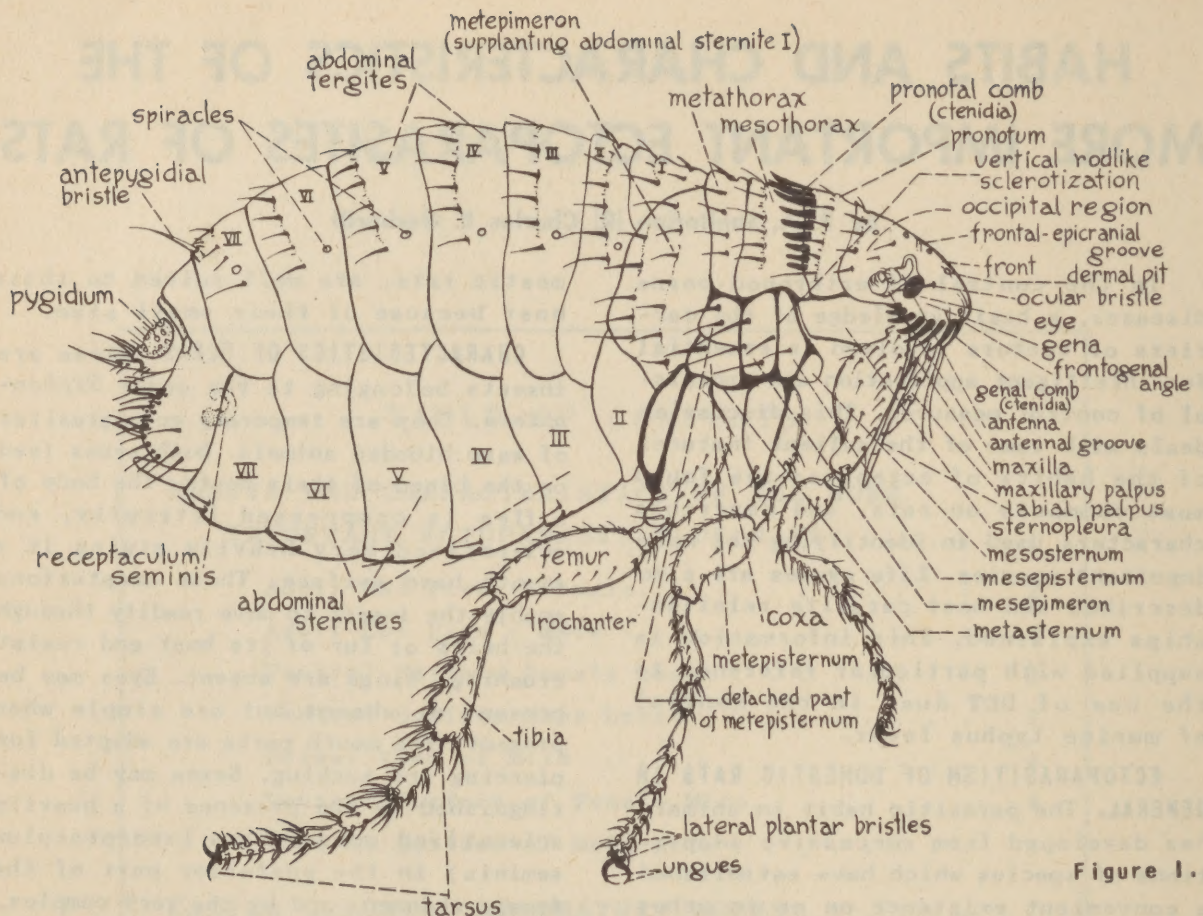


Figure 1.

CTENOCEPHALIDES FELIS The Cat Flea — Adult Female

long-lived, the span of life is greater in cool, humid climates than in hot, dry ones. According to experimental evidence, active adults of some species can survive for nearly two years if conditions are favorable, even though their hosts are not present. These long periods of survival usually account for the presence of fleas in places which have been unoccupied by their hosts for months.

FLEAS FOUND ON RATS. Adult fleas visit their hosts primarily to secure food. They are frequent feeders, and often take more food than they require. Although fleas generally have a preferred host, they do not have an obligatory host. Many species pass readily from animal to animal. The cat flea, for example, is often found on dogs, rats,

or man. Results of investigations indicate that rat fleas spend less than one-third their adult life on their hosts, the remainder of the time being spent in the runs, harborages, and other places frequented by their hosts.

Fleas associated most frequently with domestic rats are *Xenopsylla cheopis*, the oriental rat flea; *Nosopsyllus fasciatus*, the rat flea; *Leptopsylla segnis*, the mouse flea; *Echidnophaga gallinacea*, the chicken or stick tight flea; *Ctenocephalides felis*, the cat flea; and *Ctenocephalides canis*, the dog flea.

In addition to these, certain other fleas are found less frequently on rats. Among them are *Pulex irritans*, the human flea; *Hoplopsyllus affinis*, a western species found mostly on rabbits;

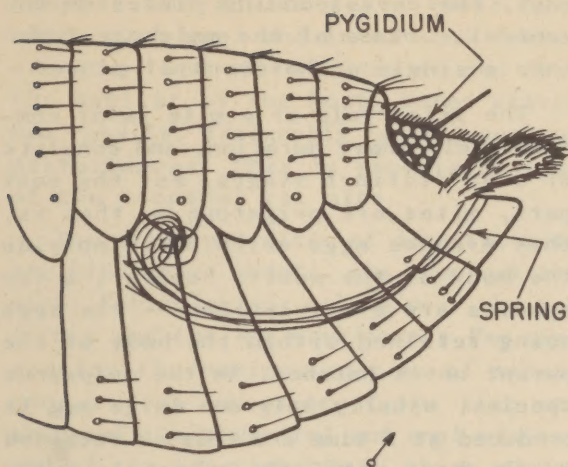


Figure 2. CTENOCEPHALIDES FELIS — The Cat Flea. Part of the abdomen of the male flea.

Ctenophthalmus pseudagyrtes, frequently associated with moles; *Stenoponia americana*, an eastern species found on native mice; *Epitedia wenmanni*, an abundant eastern species associated commonly with squirrels; *Cediopsylla simplex*, found on numerous kinds of animals; *Oropsylla montana*, normally parasitic on California ground squirrels; *Rhopalopsyllus gwyni*, found on rice-rats, cotton rats, and domestic rats; and *Orchopeas howardii*, found on squirrels. The accompanying pictorial key to the identification of fleas points out the differences in these species.

LICE FOUND ON RATS. Rat lice are included in the *Anoplura*, an order of insects which are wingless, and have the body flattened dorso-ventrally. Their bodies are soft and pliable because of the small degree of sclerotization. They rest parallel to the skin of their host. This is in direct contrast to the flea whose body rests perpendicularly to the skin of its host, and whose body is heavily sclerotized. Rat lice have tarsi or feet which terminate in a single claw. This facilitates grasping and clinging to hairs. The eyes are reduced or absent. Mouth parts are especially well adapted for piercing the skin of the host and for sucking blood.

The sexes of lice may be distinguished by the form of the ninth ab-

dominal segment. In the male this segment terminates in a rounded point; in the female, it is notched, and forms two flaps, the telson. (See Figs. 3 & 4.)

Lice pass through an incomplete metamorphosis in their development. Eggs hatch into young which resemble the adults very closely. Newly-hatched lice are called nymphs. They undergo at least three molts before reaching the adult stages. Lice are parasitic during all stages of their life beginning with the egg stage. The eggs are attached to the hairs of the host by an agglutinous substance. Several species of lice are parasitic on rodents. *Polyplax spinulosa* is well named "the rat louse" since it is the species encountered most frequently. Two Hoplopleurine lice, *Hoplopleura acanthopus*, and a species as yet undetermined are generally found less frequently. Characters used for determining the species are the sternal plates of the second and third abdominal seg-

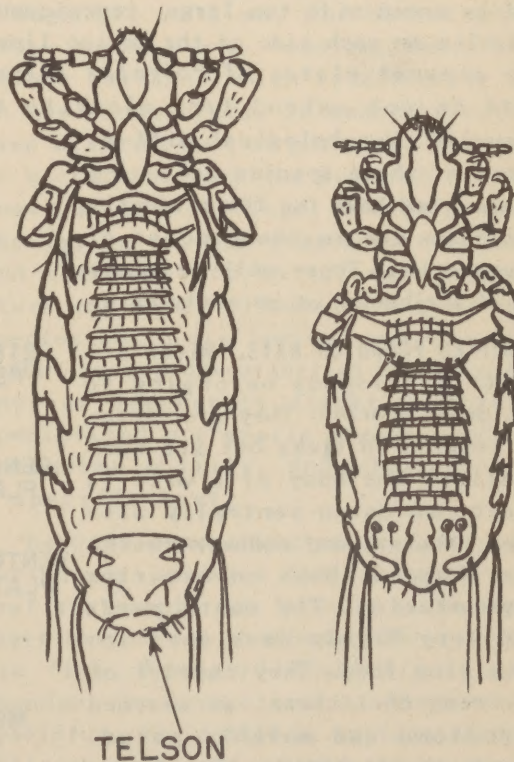


Figure 3. (Left) Ventral Surface of Female Louse. Figure 4. (Right) Ventral Surface of Male Louse.

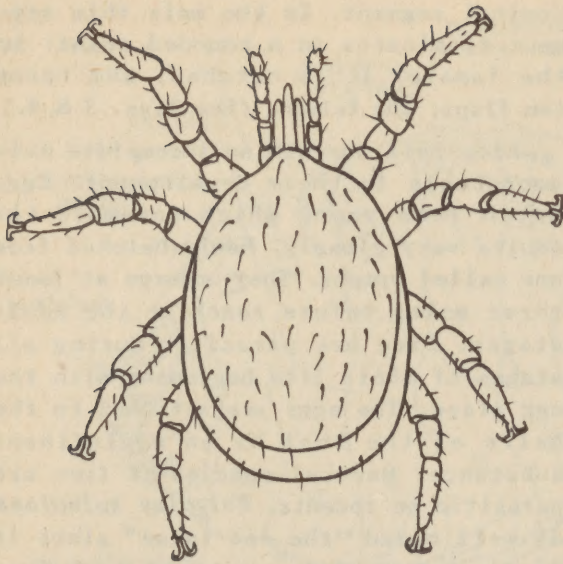


Figure 5. Dorsal View of Mite.

ments, the size and shape of the pleural plates, and the arrangement of the bristles on these plates. The sternal plate of the third abdominal segment of *Hoplopleura* extends from pleurite to pleurite, and is armed with two large, conspicuous bristles on each side of the median line. The sternal plates of *Polyplax spinulosa* do not extend from pleurite to pleurite. Morphological differences of these species are being studied and keys for their identification are in the process of preparation. These will be ready for distribution at an early date.

MITES FOUND ON RATS. Mites are small arthropods belonging to the order *Acarina*. They are closely related to ticks but are much smaller. The body of a mite is flattened dorso-ventrally with head, thorax, and abdomen fused. The abdomen shows no exterior segmentation. The mouth parts are very highly developed for obtaining food. They consist of piercing chelicerae, an unarmed hypostome and movable palpi. Sexes are distinct. (See Figs. 5, 6, & 7.) Four major plates are found on the ventral surface of the female mite; they are the sternal, genital, ventral, and

anal. The corresponding plates on the ventral surface of the male are fused into a single or holoventral plate.

The life cycle of a mite is of comparatively short duration, and consists of five distinct stages. For the most part, mites are oviparous — that is, they produce eggs which hatch outside the body of the adult; however, a few species are ovoviviparous — the eggs being retained within the body of the parent until hatched. In the oviparous species, usually only one large egg is produced at a time and this is retained in the body until the embryo is quite well developed. The larval form has only three pairs of legs, and is similar to the adult in appearance and habits. Usually two nymphal stages occur: first, the eight-legged protonymph; second, the eight-legged deutonymph. The nymphs resemble the adults but may be distinguished from the latter by the absence of the genital openings. The adult stage follows that of the deutonymph.

Most of the mites parasitic on rats use only blood for food. The larvae,

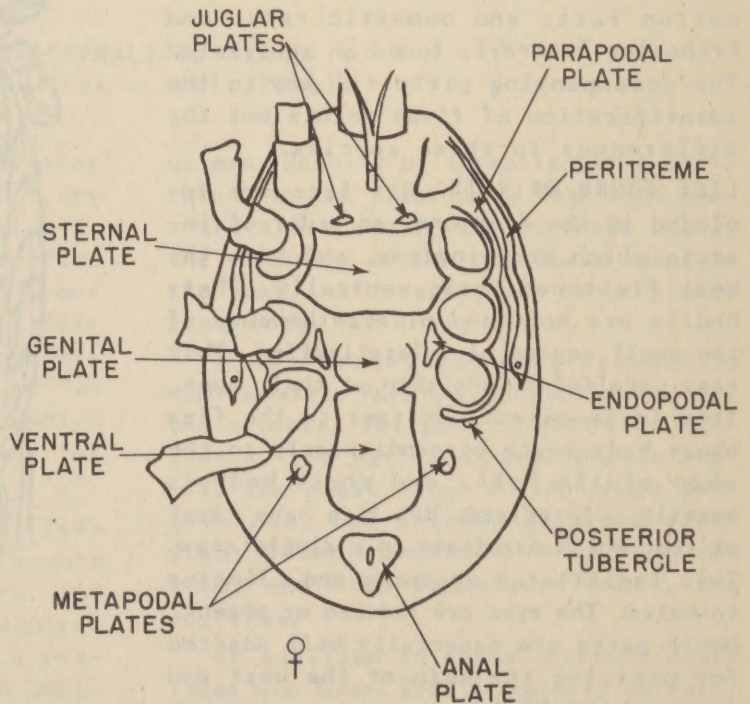


Figure 6. Ventral Surface of Female Mite, showing plates. Drawing according to Ewing.

nymphs, and adults leave their host after each meal and infest rat nests, crevices, and other places in and near the habitat of the host. Mites attack man readily, frequently causing serious disturbances. This is especially true of the tropical rat mite.

The principal mites of domestic rats are *Liponyssus bacoti*, the tropical rat mite; *Echinolaelaps echidninus*, the rat mite; and *Laelaps hawaiiensis*. For separating the various species of mites, comparisons are made of the size and shape of their ventral and anal plates, and of the relationship of these plates to each other. These characters are used only for separating the females. The males are found less commonly, and have not yet been described for some species.

Two other species found less frequently on rats are *Artricholaelaps glasgowi* and *Eulaelaps stabularis*. *Artricholaelaps glasgowi* has a much reduced ventral plate and an anal plate as broad as it is long. *Eulaelaps stabularis* has a large, well developed ventral plate slightly concave at the posterior part, and an anal plate much broader than long. *Artricholaelaps glasgowi* is a blood-sucking species, but *Eulaelaps stabularis* is not.

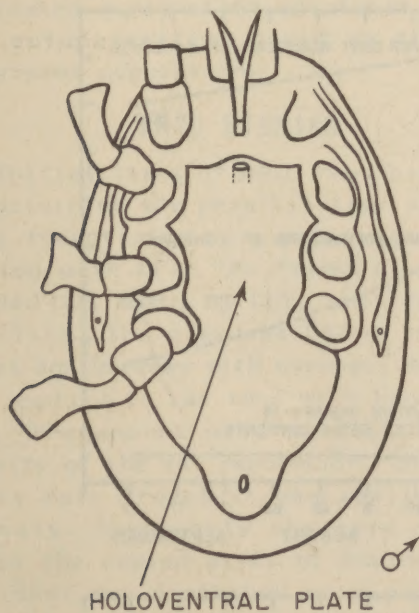


Figure 7. Ventral Surface of Male Mite.

Taxonomic investigations of the *Acarina* have been somewhat meagre. In the short time that DDT has been used in the Typhus Control Program, entomological evaluation of results has shown that several additional species are quite common in a number of localities. A key to the species of mites most commonly found on rats, is being prepared and will be available for distribution soon.

TEMPERATURE AND CLIMATE IN RELATION TO RAT ECTOPARASITISM. Flea and mite populations of rats tend to become somewhat reduced during the cooler months, even though these ectoparasites breed throughout the entire year in some localities. On the other hand, lice seldom leave their rat host, and thus are not affected greatly by temperature and other climatic changes. Flea and mite populations on rats tend to be relatively uniform in any locality although all rats may not be infested. Louse populations, however, tend to be either extremely high or extremely low on individual rats. In general, extensive distribution of parasites seems to be correlated with the presence of adequate ambulatory legs, ovoviviparity, the laying of eggs away from the host, and some ability to tolerate temperature and other climatic changes. Many species which are limited in their distribution are characterized by the presence of degenerate digestive organs, specialized prehensile organs, reduced locomotor ability, and adaptation to a specific host.

As data concerning parasite distribution are somewhat limited, only general statements can be made as to their distribution and abundance. The oriental rat flea, *Xenopsylla cheopis* is most abundant in warm climates. *Nosopsyllus fasciatus*, the rat flea, replaces *Xenopsylla cheopis* to a certain extent during the cooler months, and is generally most abundant in the more temperate climates. The tropical rat mite, *Liponyssus bacoti* seems to prefer a sub-

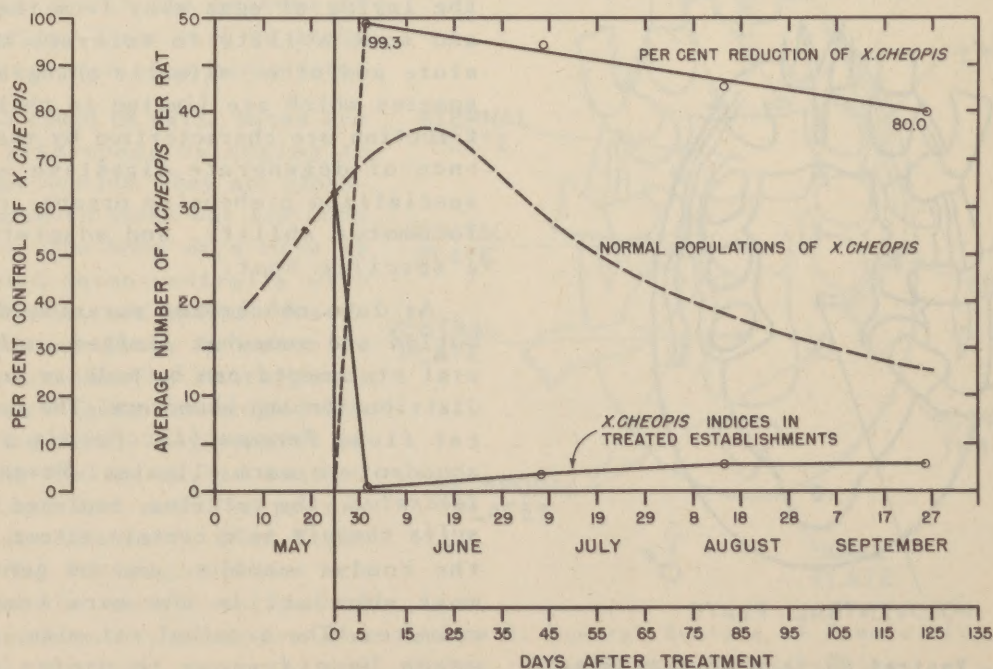
tropical climate and is found more commonly in warm than in cold regions. *Echinolaelaps echidninus* and *Laelaps hawaiiensis* are about equally abundant in the more temperate zones. The distribution of *Artricholaelaps glasgowi* and *Eulaelaps stabularis* is somewhat scattered.

ECTOPARASITES AND TYPHUS FEVER. The significance of rat ectoparasites in the epidemiology of murine typhus fever is not entirely understood. However, experiments have shown that certain fleas, mites, and lice, are capable of maintaining reservoirs of this disease among rodents. Two species of fleas, *Xenopsylla cheopis* and *Nosopsyllus fasciatus* have been incriminated, as have the tropical rat mite, *Liponyssus bacoti*,

and the rat louse *Polyplax spinulosa*.

Recent investigations have demonstrated that DDT dust can be used successfully to reduce the numbers of certain rat ectoparasites, particularly the fleas. Application of the dust is a simple and rapid procedure. It is expected that DDT dust will prove to be an important means of controlling epidemics or sudden outbreaks of murine typhus fever. If it also proves effective in preventing infection among rats, it will be an important means of long range typhus prevention. However, it is believed that DDT dusting must be used as a supplement to, rather than a substitute for permanent sanitation measures such as rat stoppage and rat eradication in public health programs.

FIG. I CONTROL OF *X. CHEOPIS* FLEAS WITH 10% DDT DUST
MODERATE TO HEAVY DOSAGES - ELEVEN URBAN ESTABLISHMENTS
(APPROXIMATELY 8 POUNDS PER ESTABLISHMENT)



CARTER MEMORIAL LABORATORY NOTES

TYPHUS CONTROL INVESTIGATIONS

Additional information concerning the effectiveness of DDT dust used against rat ectoparasites has been secured. Data were collected from eleven establishments, including three meat and grocery stores, two wholesale groceries, two poultry stores, one cafe, one warehouse, one feed store, and one chicken hatchery. Ten percent DDT dust was used in moderate to heavy dosages of approximately eight pounds per establishment. Fig. 1, page 6, presents graphically the control of *Xenopsylla cheopis* obtained by the use of DDT dusts, as weighted by normal population observations over the same period.

Effects of normal residual spraying procedures upon rat ectoparasites were observed in nine residences and three restaurants. The buildings were sprayed with a normal residual spray of 200 mg. per square foot, applied only to walls and ceilings. Examinations of rats were made before spraying was done and again six to twelve days afterwards. Results indicated a reduction of almost 97% of the ectoparasites, based on the pre-treatment population.

ANTU STUDIES

Initial tests of ANTU have been made to determine the possibilities of using this rodenticide as a poison in combination with DDT. The formula used included 20% ANTU, 8% DDT, and 72% pyrophyllite. The dust was blown into rat holes and burrows with cyanogas dusters, and applied to rat runs with hand shakers. The amount used varied with the density of the rat population. In places where rats travel it was applied generously. Apparently the rats did not avoid the dusted areas or burrows, for the dust was disturbed or wiped up in many places; in others, rat tracks were evident.

At times it was difficult to estimate the number of kills among the rat population because of the scarcity of dead rats. According to some investigators, however, rats tend to remain in burrows dusted with ANTU and to die there. This may have been the case in a certain shipyard where workmen observed only a few dead rats on the premises after ANTU dusting operations. Live specimens were much less in evidence after the dusting than they were before.

The greatest number of kills occurred within the first fifteen to twenty hours after application of ANTU. Usually a few sick rats were seen during the first inspection. Killing extended over a period of seven days; few rats, however, died after the fourth day. As indicated by subsequent poisonings with 1080 and by trapping, some rats remained alive in all the establishments treated.

Since rats develop a tolerance to ANTU very quickly when a sub-lethal amount is taken, it is felt that even better results might have been obtained if dust with more than a 20% ANTU content had been used. In the next series of tests a dust composed of 50% ANTU and 10% DDT will be used.

ANOPHELINE HOST PREFERENCE STUDIES

Specimens of female *Anopheles quadrimaculatus* were collected from sprayed and unsprayed sections of the various states participating in the extended MCWA program. The accompanying table (See page 8, Table I.) shows a comparison of numbers of specimens from each area which fed on human blood. As indicated, the number of mosquitoes feeding on human blood was about 80 to 85 percent greater among specimens from unsprayed areas than among those collected in sprayed areas.

TABLE I
RESULTS OF TESTS FOR HUMAN BLOOD MEALS
OF A. QUADRIMACULATUS SPECIMENS
FROM SPRAYED AND UNSPRAYED AREAS

STATE	SPRAYED AREA		UNSPRAYED AREA	
	NUMBER SPECIMENS TESTED	A. QUADRIMACULATUS NO. FEEDING ON HUMAN BLOOD	NUMBER SPECIMENS TESTED	A. QUADRIMACULATUS NO. FEEDING ON HUMAN BLOOD
Alabama	110	0	8	0
Florida	59	1	1,393	13
Louisiana	56	0	59	0
Mississippi	324	5	57	4
Missouri	37	0	---	--
Oklahoma	68	1	2	1
S. Carolina	2,591	1	629	18
Tennessee	457	2	22	0
Texas	8	0	---	--
TOTALS	3,710	10	2,170	36
PERCENT		.27		1.7

TYPHUS PERSONNEL MAY BE VACCINATED

The Medical Division of MCWA announces that typhus fever vaccine is now available to all Typhus Control field employees who desire to be vaccinated.

The vaccine, prepared from chick embryo, is still in the experimental stage in regard to its known value in the prevention of the disease in man. Records are being kept for each person vaccinated. The Medical Division, and the Lederle Company which is supplying the vaccine, will use these data as a basis for evaluating the vaccine.

The vaccine is administered subcutaneously in three doses of one cubic centimeter each, at intervals of five to seven days. Blood samples are taken before and after vaccination, and the specimens shipped to the Lederle Laboratories for examination.

Vaccines, venules for taking blood samples, and sets of record cards may be requisitioned from the Medical Division. The quantity of vaccine is limited.

ATLANTA TYPHUS PROGRAM STARTED

A project proposal for the inauguration of a DDT dusting and ratproofing program in the city of Atlanta was established by the Training and Education Division during October. Asst. San. (R) Vinton W. Bacon, head of the Typhus Control Section and formerly chief of the Typhus Control Division of the San Antonio, Texas, Health Department, was appointed general supervisor for the program.

DDT dusting has been carried on by two regular crews, assisted by trainees enrolled in the DDT Dusting and Intensive Typhus Control courses.

HEADQUARTERS NOTES

NEW FILMS AVAILABLE

The following motion pictures and film strips are now available for unrestricted distribution:

THE REARING AND HANDLING OF MOSQUITOES is a 600-foot sound motion picture in black and white, showing methods of handling mosquitoes in insectaries. Production Number is MCWA-TE-4-006.

MOSQUITO PROOFING (EDITION II) is a black and white sound edition of the original motion picture in color. Sufficient copies are on hand to make this film readily available. The picture is 400 feet in length; running time is ten minutes. Production Number is MCWA-TE-4-026.1.

Released by the OWI, **SOLDIER FROM THE TROPICS** is a dramatic film showing how malaria might be transmitted in the United States when brought into the country by a soldier returned from the tropics. This is a sound motion picture about 400 feet in length, running time about ten minutes. **SOLDIER FROM THE TROPICS** is a production of the Office of War Information released through MCWA. Production Number is 4-030.

DDT POWER SPRAYING is a new film strip in color made to replace the original black and white. This film has a recorded narration which runs 15 minutes. Production Number is MCWA-TE-5-002.1.

SCHISTOSOMIASIS (EDITION I) A film strip in full color with recorded narration, is designed for showing to physicians and medical students. The film runs fifteen minutes and gives clinical, laboratory, and therapeutic information concerning the disease. Production Number is MCWA-TE-5-006.

PERMANENT DITCH LININGS — Part I, Monolithic Concrete Linings — is a training film strip in natural color. The film runs 15 minutes and the Production Number is MCWA-TE-5-034. The advantages

of permanent ditch lining are demonstrated to a city council and actual steps of installing monolithic lining are shown.

YOUR UNINVITED GUEST is available in a Spanish edition black and white film strip. This film was released originally in black and white with English narration. Copies are available for immediate use. Production Number of the English version is MCWA-TE-5-001. The Spanish is MCWA-TE-5-001.2. Both are sound films.

THE MALARIA MOSQUITO, a black and white silent film strip made for the Arkansas State Health Department, is now available. Production Number is MCWA-TE-5-029.

RECOGNITION OF RAT SIGNS IN DDT DUSTING, a black and white film strip with sound, has been released recently for unrestricted distribution. This is a training picture to be used in teaching labor crews the fundamentals of recognizing rat signs in the control of typhus with DDT dust. Production Number is MCWA-TE-5-027.

MALARIA PAMPHLET AVAILABLE

SO YOU'VE HAD MALARIA is the title of a pamphlet now available for returned veterans who may be carriers of malaria. Designed for free distribution through State and local health departments, the pamphlet describes what the veteran can do to protect the future health of himself and his family, and the desirability of cooperation in community malaria control efforts.

AEDES AEGYPTI CAR CARDS

Aedes aegypti street car cards are available for posting in public conveyances. They stress the importance of *aegypti* control, and point out ways in which the householder can aid in controlling this mosquito. The cards measure approximately 23 by 28 inches. They are available for use in state and local health programs.

FRENCH OFFICIALS VISIT MCWA

Dr. Bernard Le Bourdelles, Directeur Regional de la Sante and de l'Assistance in Orleans, France, and his interpreter Dr. Pages of the French Army, visited MCWA Headquarters during October. They came directly from Washington, D. C. to Atlanta, where they observed activities in the MCWA Headquarters Office, and visited the various divisions of the Georgia State Health Department.

Dr. Lourdelles said that the primary purpose of his trip to the United States was to observe medical care facilities in this country, with a view to improving facilities in his district in France.

According to S. A. Surgeon Robert H. English who conducted Dr. Bourdelles' tour of the Headquarters office, the visitor expressed a great deal of interest and enthusiasm for the developments which he observed in this country, and was especially interested in the methods used in training public health workers.

VISITORS TO HEADQUARTERS

Recent visitors to the MCWA Headquarters Office included Dr. J. R. Herrera, Director General of Public Health of Guatemala. Of particular interest to Dr. Herrera were the new Tropical Disease Laboratory and the typhus and malaria films shown him in the In-Service Training Section of the Training Division.

Lt. Albert E. Mead, from Oakland, California, visited the In-Service Training Section to obtain information on the Typhus Control Program.

Visitors to the residual dusting program included David Waldrop and John Brandenburg, Arkansas State Board of Health, and Asst. San. Engr. (R) Joe Beall, Assistant State Director of Typhus Control, State of Georgia.

November visitors to the In-Service Training Section included Miss Margaret E. Barron, Chief, Employee Counseling and Service, Division of Personnel Management, F.S.A., Washington, D. C.; Dr. M. A. Abbasy, Prof. Hygiene and Rev. Medicine, Farouk I University, Alexandria, Egypt; Mr. Wah Choy Ching, UNKRA Health Division, Washington, D. C.; Dr. Smiljana Mikacic, Zagreh Hygienic Institute, Yugoslavia; Sr. Surgeon (R) Francisco J. Dy, Office of U. S. High Commission, San Francisco, Cal.; and Dr. Hernando Key, Division of Malarology Bogota, Colombia.

Upon request, visitors were supplied complete sets of literature, training aids, and films.

NEW TRAINING DIVISION PERSONNEL

Additions to the staff of the Training and Education Division during October include Miss Sara McCorkle, who will assist in protozoological work, and Asst. San. (R) Geoffrey M. Jeffery. Dr. Jeffery, formerly with TVA at Wilson Dam, has been assigned to duty with the Professional Relations Section.

REFRESHER COURSE BEGINS

The first class of laboratory technicians to take the six-week refresher course in the laboratory diagnosis of parasitic diseases, started October 1, under the direction of Surgeon Seward E. Miller, Head of the Tropical Disease Section.

During the first two weeks of the course, the class studied the malaria parasite, under Miss Aimee Wilcox of the Memphis laboratory. The program for the next four weeks consisted of a study of general protozoology and helminthology.

The next class is scheduled to start January 7.

HOWARD ADDRESSES ENGINEERS

San. (R) R. S. Howard, Jr. gave an illustrated lecture on malaria control to the Atlanta Chapter of the American Society of Military Engineers on October 8.

THIRTY-ONE COMPLETE TYPHUS COURSE

The fourth six-week intensive course in typhus control, with a total enrollment of 31, was completed Dec. 14. Asst. San. (R) Vinton W. Bacon was in charge of the course.

NEWLY COMMISSIONED OFFICERS

Two newly-commissioned officers reporting for active duty in October were Asst. San. (R) Harold Ansell and San. (R) N. Bader who were assigned to the typhus course. Upon completion of the course, Dr. Bader reported to Thomasville for the Southern Georgia Typhus Control Investigation program. Lt. Ansell was assigned to Albany, Georgia.

MURRAY RECEIVES TRANSFER

S. A. Engr. (R) William C. Murray has been transferred from the Arkansas MCWA program to the Impounded Waters Section headquarters in Atlanta.

SANITARIANS STUDY INSECTS

A one-day course on Insects of Public Health Importance was presented Dec. 7, by S. A. Engr. (R) Ernest P. Dubuque to sanitarians enrolled in the Public Health Internship training course. The course included a demonstration of insects of Public Health importance; a brief account of the Murine Typhus Control program; a discussion of insect control; a demonstration of DDT spraying and dusting; the showing of films on insects and the use of DDT; and the distribution of literature on insects and their control with DDT.

TWO NEW COURSES OFFERED

Training courses for October consisted of two two-week courses in residual dusting for typhus control and a two-day presentation of medical entomology to trainees in the Laboratory Diagnosis of Parasitic Diseases class. Thirty-three completed the course:

The two-day course in medical entomology covered the following outline.

- I. Parasites and Parasitism
- II. Types of Diseases Transmitted by Arthropods
- III. General Classification and Life History of Arthropods.
- IV. Laboratory Exercises in Identification of Certain Arthropods to Classes or Orders.
 1. Identification of classes of Arthropods of medical importance
 2. Identification of orders of Arachnids of medical importance.
 3. Identification of orders of Insects of medical importance.
- V. Characteristics, Life history, Distribution, and Role in transmission of human Diseases of the Various Species of Arthropods of Medical Importance.
- VI. Laboratory Exercises in the Identification of Some Important Members of the Orders Hemiptera and Diptera.
- VII. Practice in the Use of Keys for Identifying Certain Arthropods to Species.
 1. Fleas 2. Mosquitoes
- VIII. Practice in General Recognition of Various Life History Stages other than the Adult Stage.
 1. Anopheline larvae
- IX. Control of Arthropods of Medical Importance.
- X. Demonstration of Control Work.
- XI. Sources of Literature for Reference.

DIVISION NOTES

SAVANNAH GETS NEW PLANES

The Engineering Division has announced the purchase of two airplanes to be used for thermal aerosol experimental work at Savannah, Ga. The planes, formerly owned by the Army, and used in TVA work at Muscle Shoals, Ala., were ferried to Savannah during the week of October 15.

HENDERSON INSTRUCTS AT COLUMBIA

Sr. San. Engr. (R) John M. Henderson, head of the Engineering Division, was on temporary detail for six weeks in September and October at Columbia University in New York. As Professor of Sanitary Science, Henderson conducted a class for thirty-three graduate students who were candidates for the degree of Master of Public Health.

HYACINTH ERADICATION IN SOUTHERN STATES

The United States Public Health Service has been invited to cooperate and participate in studies to be conducted by the War Department, Office of the Chief Engineer, on the possibilities of water hyacinth eradication in the southern states. Plans for the inauguration of these studies are now being made by the War Department.

Tentative assignments to Divisional Committees to work out details of the studies are as follows: Sr. San. (R) G. H. Bradley, Atlanta, Georgia; S. A. San. (R) Leslie D. Beadle, Texas; and San. (R) Travis E. McNeel, Mississippi.

TRAINING COURSE FOR SANITARIANS

A two-week training course for sanitarians was presented Dec. 3-15 by personnel of the Interneship Training Section of the Training and Education Division.

The course, developed at the request of the Atlanta Health Depart-

ment, consisted of a week of lectures and demonstrations, and a week of supervised practical training in carrying on restaurant sanitation activities in the field. The lectures and demonstrations included such subjects as the development of sanitation programs; the U.S.P.H.S. Restaurant Ordinance and Code; bacteriology in relation to food poisoning; sanitization of dishes; personal hygiene and handling of utensils; organisms important in food poisoning; insects of public health importance; murine typhus control, rat control, and insect control; and practical procedures in education and inspection related to food sanitation.

Sr. San. Engr. Ellis S. Tisdale and S. A. Surgeon Robert H. English of the Interneship Training Section were in charge of the course. They were assisted by Dr. T. H. Butterworth of the U.S.P.H.S. Food and Milk Control Unit, Washington, D. C.; San. Engr. (R) L. H. Male of the U.S.P.H.S. District 4 Office, New Orleans, La.; Surgeon Seward E. Miller and staff, Laboratory Section, Training and Education Division; and S. A. Engr. (R) Ernest P. Dubuque, In-Service Training Section, Training and Education Division.

ENTOMOLOGISTS ATTEND TEXAS MEETING

Sr. San. (R) G. H. Bradley, S. A. San. (R) Herbert Knutson, and S. A. San. (R) Roy F. Fritz attended the annual meeting of the American Association of Economic Entomologists held December 3, 4, and 5 in Dallas, Texas.

At a symposium on the training of entomologists for special fields of activity Sr. San. (R) Bradley and S. A. San. (R) Knutson presented a paper entitled, "The Training of Entomologists for Professional Public Health Work." Capt. Knutson showed the film, "Anopheles Census," and distributed copies of MCWA entomological training aids.

DDT DUSTING IN SOUTHERN GEORGIA

In cooperation with MCWA, during December The Georgia State Health Department started an investigation program in southern Georgia to evaluate the use of DDT dusting in the control of typhus fever. San. (R) Essex is in charge of field operations.

NEW 9TH SERVICE COMMAND LIAISON OFFICER

Engr. Paul Anderson was assigned recently as liaison officer with the 9th Service Command, Salt Lake City, Utah. Formerly assistant state MCWA director for Florida, Maj. Anderson has just completed an assignment with UNRRA. He will be concerned with all MCWA activities in the 9th Service Command, which comprises the Rocky Mountain states and Washington, Oregon, and California.

THREE-DAY ORIENTATION COURSE

A three-day orientation course for Training and Education Division employees was conducted in December by the In-Service Training section.

IMPOUNDED WATER STUDIES EXPANDED

Sr. San. Engr. (R) John M. Henderson, Chief of the Engineering Division, has announced that the Impounded Waters section will undergo considerable expansion during the next six months. The expanded program will include approximately 200 studies of possible malaria problems involved in reservoir and dam construction by the U. S. Engineers.

The studies will be conducted by the Headquarters Engineering Division in cooperation with the state health officers and the Medical and Entomological Divisions. While greatest emphasis will be given to projects in endemic malaria states, the program will be nation-wide in scope and will cost several million dollars.

To date, reports on fifteen Impounded Water Survey projects have been submitted to the U. S. Engineers, and

field work and rough draft of reports for thirteen other projects have been completed. A total of 160 requests for malaria studies on lakes or lake sites have been received so far by the Impounded Waters Section.

Included in the studies are an appraisal of epidemiological data on malaria, a summary of entomological data, and an investigation of the physical characteristics of the territory. One of the most important features of the program is an analysis of the relationship between recreational areas with housing facilities and areas favorable to the production of *Anopheles quadrimaculatus*. The reports contain definite recommendations for the construction, maintenance, and correct planning of the different activities related to the malaria problem.

The impounded water studies are being made during the winter months, the off season for MCWA control activities. Engineers in the field are being removed temporarily from the war and extended programs and assigned to the Impounded Waters Section for work on this new program.

The following projects were completed as of Nov. 26. This list indicates the engineering districts in which they are located. 1. Cross-Florida Barge Canal, Jacksonville; 2. Demopolis, Mobile, Allatoona, Mobile; 3. Whitney Dam, Galveston; 4. San Angelo, Galveston; 5. Cherry Creek, Denver; 6. New Jersey Ship Canal, New York; 7. Clark Hill, South Atlantic; 8. West Point Water Supply, New York; 9. Proposed Channel Between Manteo and Oregon Inlet, Wilmington; 10. Table Rock, Little Rock; 11. Fort Peck Dam, Fort Peck; 12. Buggs Island, Norfolk; 13. Mount Morris, Buffalo, Optima, Tulsa.

Field work has been completed on all surveys assigned an urgent priority by the U. S. Engineers, and reports on these projects will be forthcoming soon.

LITERATURE REVIEW

Malaria in the Upper Mississippi Valley 1760 - 1900. By Edward H. Ackerknecht. The Johns Hopkins Press. 1945. Pages 111 - 142. Price \$2.00.

In the middle of the nineteenth century, malaria was prevalent along the entire length of the Mississippi River, but shortly afterwards this disease began a steady retreat southward, until at the present time, it is practically nonexistent in the upper Mississippi River Valley, and is becoming scarce in the so-called "malarious South." This virtual disappearance of malaria from the northern part of the country during the past seventy years constitutes one of the most puzzling epidemiological problems concerning the disease.

In this publication from the Johns Hopkins Institute of the History of Medicine, Dr. Ackerknecht presents the most thorough and critical analysis of this interesting problem that has yet appeared in the literature. In the first portion of the book, the author discusses the rise and the fall of malaria within the five states that border the upper Mississippi River - Illinois, Missouri, Iowa, Wisconsin, and Minnesota. In the second portion, he evaluates the various factors which might have contributed to the regression of malaria from the valley. This epidemiological study has entailed careful and diligent search through a tremendous number of historical records and scientific publications. It might be suspected that such a publication would contain so much factual information that it would be dry and uninteresting. Apparently, the author was aware of this possibility as is indicated by the following statement in his preface: "I invite the reader to use a little bit of his own imagination and not to forget the great human drama that is hidden behind the rather dry statistics and quotations

which will be found in the following pages." However, there was no need of his being concerned, for his publication is an intensely interesting and enjoyable scientific monograph. One is aware constantly that the author's subject is "a part and parcel of one of the most fascinating episodes in human history; the conquest and settlement of the West, the great continental heart of North America."

In considering factors which might have played a part in the disappearance of malaria within the region, the author discusses population movements, railroads, steamships, river regulations, clearing, cultivation, drainage, prosperity, housing, screening, food, education, cattle breeding, mosquitoes, quinine, climate, and weather. Several of these factors have been proposed by other writers on the subject, but never before has the actual historical and epidemiological evidence, both for and against each factor, been gathered together in such a thorough manner, and analyzed so carefully.

It is the general conclusion of the author that no one factor can be singled out as the main or exclusive agent responsible for the disappearance of malaria. The arresting of population movements and the shifting of settlements from the water courses inland would seem to have been of considerable importance on the basis of statistical relationship. The organization of drainage enterprises along the Mississippi occurred too late to be of any influence. The effect of small scale local drainage is impossible to measure. Apparently there is a correlation between the building of better homes and the decline of malaria, although the screening of homes occurred so late that it is difficult to estimate its influence on the disappearance of the disease. The increase in numbers of dairy cattle,

and the general increase in wealth of the region obviously had their influence upon the situation. Although climatic conditions in the region were none too favorable for the transmission of malaria, nevertheless they were in effect throughout the entire period. The author points out, "It is well to remember that malaria in the Upper Mississippi Valley was not killed by a single magic bullet; the monster was only put in chains, the links of which we have tried to study. Each link of the chain is important, and the breaking of one link may set free again the evil fiend."

Dr. Ackerknecht further points out that the 1940-42 REPORT ON MALARIA SURVEY ALONG THE UPPER MISSISSIPPI RIVER shows that *Anopheles quadrimaculatus*, the main vector of malaria, is found everywhere in this region, sometimes in great densities. Two doubtful vectors of the disease, *Anopheles occidentalis*, and *Anopheles walkeri* also exist in great densities. The Upper Mississippi Valley is thus another beautiful example of "Anophelism without malaria."

The question arises as to whether these *Anopheles* are actually the same "mosquitoes" mentioned in the heyday of malaria and are ineffective only because of the lack of carriers or because their victims have moved away. The author indicates that they seem to be the same species as those described by Howard, Dyar and Knab in 1912-1917.

There is nothing in the author's findings to indicate that there is a correlation between the time of the introduction of quinine and the decline of malaria. However, he believes that quinine may have had an indirect effect by making it possible for people within the region to tolerate the situation and to devote their energies to the improvement of the region. It is well to quote directly, the author's stand on this subject: "What role did quinine play in the nineteenth century in the upper Mississippi Valley? The

right answer is not to be found in assumed but nonexistent specific merits of quinine. Quinine does not avoid infection; quinine does not sterilize the carrier. Quinine, therefore, cannot have a direct effect on the eradication of malaria from a community. Whoever tries to link quinine directly with the disappearance of malaria because quinine is the most direct anti-malarial measure, is pleading a lost cause, because he is pleading against the evidence. But quinine does have one quality which nobody denies and which may be decisive in certain historical situations; it stops the clinical attack; it makes people fit to fight and to work, when without quinine they would be unable to do so."

It is interesting to read the author's findings on Doctor J. Sappington, who introduced his famous "Anti-fever pills" during the early 1830's. The use of this patent medicine containing a certain amount of quinine spread all over the West. As a consequence, Sappington has been considered by some writers to be a kind of midwestern "culture hero," another Gorgas, a man with a great medical insight of disease, one who championed the use of quinine treatment within the Mississippi Valley, and who was subjected later to the snobbery and jealousy of his professional colleagues of the time. Dr. Ackerknecht debunks thoroughly these assertions and comes to the final conclusion that there are four things that Sappington most certainly was not -- "the promoter of quinine in the Mississippi Valley, a great doctor, a great humanitarian, or a misunderstood genius."

At the end of the book, the author does not pretend to give a complete bibliography on the subject, but simply presents an alphabetical list of books and articles which were actually quoted in this thesis. There is no index, but a somewhat detailed table of contents.

-- S. A. San. (R) M. M. Brooke

TABLE I
NCMA Larvicide, Minor and Major Drainage
AUGUST 26, - SEPTEMBER 22, 1945

STATE	Areas in Operation	LARVICIDAL WORK										DRAINAGE OPERATIONS										Total Man-Hours
		RESIDUAL SPRAYING		LARVICIDE USED		SURFACES TREATED ACRES		CLEARING		NEW DITCHING						Ditch Lining Lin. Ft.	Underground Drainage Lin. Ft.	Fill (Y)	Water Surf. Eliminated Acres			
		Number Hours Sprayed	Pounds DDT Used	Oil Gals.	Pints Green Uba	Grass Acres	Dusted Acres	Aquatic Veg. Acres	Land Veg. Acres	Clearing Lin. Ft.	Hand	Lim. Ft. Mach.	Dynamite	Total Cu. Yd.								
Alabama	8	4,912	2,491	1,518	178	52	151	1	5	17,725	---	---	---	---	---	---	---	---	3	14,126		
Arkansas	19	26,283	10,156	33,948	254	1,917	200	46	22	15,496	350	---	700	345	830	---	---	---	---	63,714		
California	4	825	113	2,132	---	178	---	1	---	20,800	---	---	---	---	---	---	---	---	---	2,556		
District I	3	---	---	2,487	6,774	53	3,636	---	1	10,000	4,503	---	---	382	---	---	---	---	---	1,402		
Florida	26	7,152	6,012	4,678	1,704	269	1,357	13	7	257,855	9,596	---	---	1,408	3,153	---	8,000	---	---	40,022		
Georgia	15	8,965	6,728	588	2,364	44	1,756	7	10	8,060	533	---	---	43	---	---	738	---	---	25,077		
Illinois	2	---	---	633	---	17	---	---	---	6,120	2,320	---	---	107	---	---	---	---	---	1,332		
Indiana	1	---	---	1,734	---	123	---	---	---	300	---	---	---	---	---	---	---	---	---	1,658		
Kentucky	10	4,593	1,870	3,688	23	200	22	3	1	---	---	---	---	---	---	---	---	---	---	13,359		
Louisiana	8	2,260	1,424	63,766	446	2,738	446	16	10	32,489	2,173	---	---	350	---	---	---	---	---	43,055		
Michigan	1	---	---	---	220	---	53	---	---	---	---	---	---	---	---	---	---	---	---	235		
Mississippi	24	21,445	10,222	15,278	1,103	628	849	43	40	25,505	1,000	---	---	23	---	---	---	---	---	44,470		
Missouri	8	5,907	3,508	7,860	4,895	501	2,101	2	2	1,500	---	---	---	---	---	---	---	---	---	23,967		
North Carolina	13	763	281	9,425	59	334	24	28	73	170,866	5,398	---	---	673	---	560	180	3	---	22,370		
Oklahoma	9	2,624	1,195	24,305	504	1,589	300	2	1	1,000	775	---	---	101	---	---	15	---	---	19,211		
Oregon	1	---	---	125	---	2	---	---	---	---	---	---	---	---	---	---	---	---	---	80		
Puerto Rico	7	---	---	1,810	8,972	106	5,984	1	1	92,785	1,700	---	---	128	---	---	---	---	---	38,540		
South Carolina	22	9,289	4,347	13,745	864	666	623	66	56	578,814	16,331	---	---	1,178	78	---	2,036	6	---	55,136		
Tennessee	3	3,581	1,502	8,994	15	287	7	---	2	605	983	---	---	97	378	---	71	---	---	15,929		
Texas	14	8,872	4,669	15,439	633	711	475	39	16	578,631	1,578	---	---	195	---	---	---	---	---	52,360		
Virginia	4	---	---	7,617	506	128	255	23	21	90,341	6,704	---	---	654	---	---	165	---	---	15,851		
Wisconsin	---	---	---	708	207	110	429	---	---	---	---	---	---	---	---	---	---	---	---	1,744		
Total	202	167,411	54,516	220,418	29,721	10,653	18,668	280	268	1,908,892	53,944	---	700	5,684	4,439	560	11,265	18	---	496,203		
Total 7:29-8:25	203	105,896	51,826	268,536	27,557	12,783	16,440	411	333	1,450,407	115,386	1,000	8,729	22,303	2,890	319	13,514	90	---	566,724		

TABLE II
NCMA Personnel on Duty and Total Payroll
SEPTEMBER 1945

STATE	COMMISSIONED		PROF. & SCI.		SUB-PROF. (1)		C. A. F.		CUSTODIAL AND PER HOUR		TOTAL		PERCENT OF TOTAL	
	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY
Alabama	5	1,527	2	467	14	3,173	3	443	35	6,117	59	11,727	141	1,95
Arkansas	13	4,007	5	1,315	40	6,681	10	1,505	412	49,611	480	63,119	1148	10,50
California	5	1,346	---	---	5	943	2	312	16	1,631	28	4,232	0,67	0,70
District of Columbia	1	332	---	---	---	---	1	212	---	---	2	544	0,05	0,09
Florida	7	2,141	4	1,290	96	17,135	10	1,179	190	24,000	307	45,745	7,34	7,61
Georgia	11	3,417	4	2,168	77	11,781	8	999	93	11,439	193	29,804	4,62	4,96
Illinois	5	1,848	2	408	1	81	1	480	5	1,480	14	4,297	0,33	0,71
Indiana	1	284	---	---	2	340	---	---	10	1,163	13	1,787	0,31	0,30
Kansas	---	---	1	178	---	---	---	---	---	---	1	178	0,02	0,03
Kentucky	5	1,467	1	246	14	2,688	4	608	65	8,288	89	13,297	2,13	2,21
Louisiana	9	2,850	3	865	47	8,349	9	1,362	249	31,895	317	45,351	7,58	7,54
Maryland	1	248	---	---	2	385	1	148	9	1,268	13	2,049	0,31	0,34
Mississippi	11	3,510	5	1,269	46	8,363	1	738	192	27,423	255	41,303	6,10	6,87
Missouri	4	1,250	1	254	19	3,133	1	143	162	19,217	187	23,997	4,47	3,99
North Carolina	4	1,765	5	1,332	9	1,889	4	654	143	17,724	165	23,364	3,95	3,89
Oklahoma	4	1,210	2	416	15	2,730	2	282	100	13,231	123	17,877	2,94	2,97
Oregon	---	---	---	---	1	178	---	---	---	---	1	178	0,02	0,03
South Carolina	13	3,828	6	1,519	51	9,499	13	1,931	385	47,614	468	64,391	11,19	10,71
Tennessee	6	1,544	2	789	19	3,045	4	1,347	82	10,252	113	16,977	2,70	2,82
Texas	10	2,975	4	1,312	67	11,168	14	2,024	278	33,166	373	50,645	8,92	8,42
Virginia	1	332	2	669	11	2,430	2	399	106	11,643	122	15,473	2,92	2,57
<i>Aedes aegypti</i>														
Alabama	1	284	---	---	4	879	1	148	---	---	6	1,311	0,14	0,22
Florida	---	---	---	---	24	4,189	---	---	---	---	24	4,189	0,57	0,70
Georgia	---	---	---	---	6	1,110	---	---	---	---	6	1,110	0,14	0,18
Louisiana	1	284	---	---	8	1,404	1	148	---	---	10	1,836	0,24	0,31
South Carolina	1	284	---	---	6	954	1	148	---	---	8	1,386	0,19	0,23
Texas	4	1,021	---	---	29	4,982	2	284	4	439	39	6,726	0,93	1,12
Hq. & District (2)	80	27,575	18	4,723	58	9,488	199	29,607	97	13,830	452	85,223	10,81	14,19
Puerto Rico	7	2,117	1	318	9	1,498	6	1,224	256	10,857	279	16,014	6,67	2,66
Honolulu T. H.	4	1,290	---	---	26	4,947	2	366	3	470	35	7,073	0,84	1,18
Total	214	68,766	68	19,538	706	123,450	302	46,691	2,892	342,758	4,182	601,203	100,00	100,00
Percent of Total	5,12	11,44	1,63	3,25	16,88	20,53	7,22	7,77	69,15	57,01	100,00	100,00		

(1) Includes Entomological Inspectors

(2) Includes Headquarters and District Offices, Mobile Units, Malaria Survey, Imported Malaria Control, Special Investigations and Employees temporarily attached to Headquarters Pending assignment to states.

TABLE III
MCWA Expenditures and Liquidations by Major Items
SEPTEMBER 1945

	CONTINENTAL U. S.	PERCENTAGE OF TOTAL	PUERTO RICO	PERCENTAGE OF TOTAL
01 Personal Services	\$578,115.43	70.36	\$16,014.38	85.02
02 Travel	23,268.97	2.83	60.24	0.32
03 Transportation of Things	3,519.20	0.43	---	---
04 Communication Service	2,525.64	0.30	20.00	0.11
05 Rents and Utilities	3,657.30	0.46	---	---
06 Printing and Binding	2,018.72	0.24	---	---
07 Other Contractual Services	18,219.95	2.22	---	---
08 Supplies and Materials	58,358.01	7.10	2,741.55	14.55
09 Equipment	131,931.54	16.06	---	---
TOTAL	\$821,614.76	100.00	\$18,836.17	100.00
Expenditures Other Than Personal Services	\$243,499.33	29.64	\$ 2,821.79	14.98

TABLE IV
Typhus Expenditures and Liquidations by Major Items
SEPTEMBER 1945

	CONTINENTAL U. S.	PERCENTAGE OF TOTAL	PUERTO RICO	PERCENTAGE OF TOTAL
01 Personal Services	\$20,677.60	86.81	\$347.68	100.00
02 Travel	---	---	---	---
03 Transportation of Things	---	---	---	---
04 Communication Services	75.00	0.31	---	---
05 Rent and Utility Service	---	---	---	---
06 Printing and Binding	---	---	---	---
07 Contractual Service	214.26	0.90	---	---
08 Supplies and Material	453.86	1.91	---	---
09 Equipment	2,397.63	10.07	---	---
TOTAL	\$23,818.35	100.00	\$347.68	100.00
Expenses Other Than Personal Services	\$3,140.75	13.19	---	---

TABLE V
Typhus Control Personnel on Duty and Total Payroll
SEPTEMBER 1945

AREA	COMMISSIONED		PROF. & SCI.		SUB-PROF.		C. A. F.		CUSTODIAL AND PER HOUR		TOTAL		PERCENT OF TOTAL	
	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY
Alabama	---	---	---	---	4	693	---	---	7	752	11	1,445	7.60	6.87
California	1	216	---	---	---	---	---	---	---	---	1	216	0.71	1.03
Florida	---	---	---	---	5	832	1	331	2	188	6	1,351	5.67	6.43
Georgia	---	---	---	---	1	162	---	---	---	---	1	162	0.71	0.77
Louisiana	---	---	---	---	3	310	---	---	2	61	5	371	3.55	1.76
Mississippi	---	---	---	---	2	382	---	---	---	---	2	382	1.42	1.82
North Carolina	1	284	---	---	4	807	---	---	7	657	12	1,748	8.51	8.31
South Carolina	---	---	1	140	8	1,270	---	---	5	127	14	1,537	9.93	7.31
Texas	2	763	1	140	41	5,547	1	131	3	684	48	7,265	34.04	34.55
Headquarters	7	2,586	1	280	14	1,604	4	529	9	393	35	5,392	24.82	25.64
Puerto Rico	---	---	1	346	---	---	---	---	---	---	1	346	0.71	1.66
Savannah Unit, Ga.	2	567	---	---	1	242	---	---	---	---	3	809	2.13	3.58
Total	13	4,416	4	908	83	11,849	6	991	35	2,862	141	21,026	100.00	100.00
Percent of Total	9.22	21.00	2.84	4.32	58.36	58.36	4.26	4.71	24.82	13.61	100.00	100.00		

TABLE VI
MCBA Larvicide, Blar and Major Drainage Work
SEPTEMBER 23, - OCTOBER 20, 1945

STATE	Area in Operation	RESIDUAL SPRAYING		LARVICIDAL BORE				DRAINAGE OPERATIONS										Total Men Hours
				LARVICIDE USED		SURFACES TREATED ACRES		CLEARING		Cleaning Lin. Ft.	NEW DITCHING			Ditch Lining Lin.-Ft.	Underground Drainage Lin.-Ft.	Fill C.Y.	Water Surf. Eliminated Acres	
		Number Houses Sprayed	Pounds DDT Used	Oil Gals.	Paris Green Lbs.	Oiled	Dusted	Aquatic Veg. Acres	Land Veg. Acres		Hand	Lin.-Ft. Mach.	Dynamite	Total Cu. Yd.				
Alabama	6	4,156	2,146	185	30	6	24	17	---	47,960	---	---	---	---	---	---	---	10,357
Arkansas	19	6,412	2,584	29,580	52	1,507	44	39	29	9,405	3,193	---	---	419	53	---	---	39,012
California	4	---	---	1,294	---	165	---	2	1	13,800	---	---	---	---	---	---	---	2,432
District I	3	---	---	568	1,516	58	932	---	---	1,200	8,461	---	---	2,413	150	---	---	1,416
Florida	25	6,561	5,571	3,832	340	161	276	17	14	266,396	9,780	---	700	1,741	1,155	---	8,525	40,019
Georgia	15	9,246	6,928	417	2,229	35	1,572	11	8	9,061	1,112	---	---	52	---	---	633	24,695
Illinois	1	---	---	269	---	8	---	1	---	5,725	---	---	---	---	---	---	---	949
Indiana	1	---	---	497	---	35	---	---	---	1,100	---	---	850	900	---	---	---	1,515
Kentucky	8	3,947	1,647	1,407	9	78	8	1	2	---	---	---	---	---	---	---	---	10,309
Louisiana	8	1,938	1,169	42,176	367	1,925	299	13	9	28,795	2,462	---	---	445	---	---	---	37,093
Mississippi	22	3,661	1,937	11,986	793	487	517	44	23	18,323	---	---	---	---	---	---	---	22,348
Missouri	5	936	612	1,751	---	109	---	1	1	---	---	---	1,200	750	---	---	---	13,142
North Carolina	12	318	148	3,474	22	144	2	26	44	199,270	8,193	---	1,225	1,180	---	356	---	15,317
Oklahoma	9	2,429	1,134	18,014	99	921	89	1	4	5,400	2,700	---	---	222	---	---	---	15,090
Puerto Rico	7	---	---	1,938	13,469	120	7,047	4	3	200,844	---	---	---	---	---	---	---	46,282
South Carolina	18	6,822	3,236	15,369	45	700	33	27	14	155,087	---	---	---	---	---	---	1,300	37,955
Tennessee	3	994	461	7,987	12	362	11	---	1	13,039	1,965	---	---	375	842	---	114	12,629
Texas	13	9,459	4,167	9,835	412	444	318	52	9	125,896	2,445	---	---	180	---	---	---	50,548
Virginia	4	---	---	5,314	226	95	114	2	21	45,237	12,155	---	---	1,471	374	---	366	14,543
Mobile U.	---	---	---	67	54	3	27	---	---	---	---	650	---	8,024	---	---	---	1,872
Total	183	56,879	31,740	155,960	19,675	7,363	11,313	258	183	1,146,538	51,466	650	3,975	18,172	2,574	356	10,938	397,523
Total 8-26 - 9-22	202	107,411	54,510	220,418	29,721	10,653	18,668	289	268	1,908,892	53,944	---	700	5,684	4,439	560	11,205	496,203

TABLE VII
MCBA Personnel on Duty and Total Payroll
OCTOBER 1945

STATE	COMMISSIONED		PROF. & SCI.		SUB-PROF. (1)		C. A. F.		CUSTODIAL AND PER HOUR		TOTAL		PERCENT OF TOTAL	
	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	PAY	PAY
Alabama	4	1,249	1	352	18	3,004	3	475	51	6,527	77	11,607	2.30	2.20
Arkansas	12	3,777	8	1,455	30	5,617	14	2,117	262	34,686	323	47,652	9.67	9.04
California	5	1,393	---	---	5	973	2	313	15	1,501	27	4,170	0.81	0.79
District of Columbia	1	333	---	---	---	---	1	196	---	---	2	529	0.06	0.10
Florida	8	2,538	5	1,438	98	16,872	10	1,562	186	23,505	307	45,915	9.19	8.71
Georgia	11	3,457	4	970	72	12,143	7	1,105	79	9,931	173	27,606	5.18	5.23
Illinois	3	952	1	89	---	---	1	148	5	609	10	1,798	0.30	0.34
Indiana	1	285	---	---	1	259	---	---	4	759	6	1,303	0.18	0.25
Iowa	---	---	1	178	---	---	---	---	---	---	1	172	0.03	0.03
Kentucky	5	1,474	1	246	7	1,687	4	608	11	5,634	28	9,649	0.84	1.83
Louisiana	8	2,461	3	865	48	8,584	9	1,367	207	29,217	275	42,494	8.23	8.06
Maryland	1	248	---	---	2	365	1	163	1	694	5	1,470	0.15	0.28
Mississippi	11	3,487	5	2,083	26	6,318	8	1,364	81	17,709	131	30,961	3.92	5.87
Missouri	2	550	1	229	14	2,533	2	614	103	11,429	122	15,355	3.65	2.91
North Carolina	4	1,472	5	1,451	5	1,297	4	666	79	10,792	97	15,678	2.90	2.97
Oklahoma	4	1,215	2	367	17	2,636	2	210	98	11,861	123	16,289	3.68	3.09
Oregon	---	---	---	---	1	215	---	---	---	---	1	215	0.03	0.04
South Carolina	11	3,314	6	1,405	69	10,310	13	1,947	286	38,363	385	55,339	11.52	10.49
Tennessee	5	1,454	2	615	18	2,875	4	802	51	7,245	80	12,991	2.46	2.46
Texas	8	2,405	2	958	53	9,705	11	1,851	150	22,386	224	37,305	6.70	7.07
Virginia	1	333	2	322	41	2,008	2	640	87	11,468	103	14,771	3.08	2.80
<i>Aedes aegypti</i>														
Alabama	1	285	---	---	4	727	1	148	---	---	6	1,160	0.18	0.22
Florida	---	---	---	---	24	3,991	---	---	---	---	24	3,991	0.72	0.76
Georgia	---	---	---	---	6	1,078	---	---	---	---	6	1,078	0.18	0.21
Louisiana	1	285	---	---	7	1,203	1	152	---	---	9	1,640	0.27	0.31
South Carolina	1	285	---	---	6	986	1	148	---	---	8	1,419	0.24	0.27
Texas	2	570	---	---	26	4,652	3	346	3	425	34	5,993	1.02	1.14
Hq. & District (2)	92	34,613	16	4,566	54	9,366	211	33,731	74	11,765	447	94,041	13.38	17.83
Puerto Rico	7	2,036	1	297	8	1,453	6	1,480	251	12,663	273	17,929	8.17	3.40
Honolulu T. H.	4	1,296	---	---	26	4,791	2	366	2	374	34	6,827	1.02	1.30
Total	213	71,757	63	17,886	656	115,648	323	52,519	2,086	269,543	3,341	527,353	100.00	100.00
Percent of Total	6.38	13.61	1.88	3.39	19.63	21.93	9.67	9.96	62.44	51.11	100.00	100.00		

(1) Includes Entomological Inspectors

(2) Includes Headquarters and District Offices, Mobile Units, Malaria Survey, Imported Malaria Control, Special Investigations and employees temporarily attached to Headquarters pending assignment to states.

TABLE VIII
MCWA Expenditures and liquidations by Major Items

OCTOBER 1945

	CONTINENTAL U. S.	PERCENTAGE OF TOTAL	PUERTO RICO	PERCENTAGE OF TOTAL
01 Personal Services	\$502,599.05	71.17	\$17,929.46	85.64
02 Travel	30,087.90	4.26	571.80	2.73
03 Transportation of Things	5,168.24	0.73	---	---
04 Communication Services	1,367.35	0.19	19.92	0.10
05 Rent and Utility Service	4,900.17	0.69	---	---
06 Printing and Binding	4,800.09	0.68	---	---
07 Other Contractual Service	20,884.05	2.96	457.00	2.18
08 Supplies and Materials	110,857.87	15.70	1,914.85	9.15
09 Equipment	14,345.42	2.03	42.30	0.20
10 Land and Structures	11,232.36	1.59	---	---
TOTAL	\$706,242.50	100.00	\$20,935.33	100.00
Expenditures Other Than Personal Services	\$203,643.45	28.83	\$ 3,005.87	14.36

TABLE IX
Typhus Expenditures and Liquidations by Major Items

OCTOBER 1945

	CONTINENTAL U. S.	PERCENTAGE OF TOTAL	PUERTO RICO	PERCENTAGE OF TOTAL
01 Personal Services	\$36,888.77	61.57	\$347.68	100.00
02 Travel	---	---	---	---
03 Transportation of Things	400.00	0.67	---	---
04 Communication Services	---	---	---	---
05 Rent and Utility Service	---	---	---	---
06 Printing and Binding	---	---	---	---
07 Contractual Service	179.95	0.30	---	---
08 Supplies and Material	19,289.63	32.20	---	---
09 Equipment	3,151.30	5.26	---	---
TOTAL	\$59,909.65	100.00	\$347.68	100.00
Expenses Other Than Personal Services	\$23,020.88	38.43	---	---

TABLE X
Typhus Control Personnel on Duty and Total Payroll

OCTOBER 1945

AREA	COMMISSIONED		PROF. & SCI.		SUB-PROF.		C. A. F.		CUSTODIAL AND PER HOUR		TOTAL		PERCENT OF TOTAL	
	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY
Arkansas	1	302	---	---	9	697	---	---	20	1,278	30	2,277	11.72	6.11
Alabama	1	285	---	---	7	1,142	---	---	12	889	20	2,316	7.81	6.22
California	1	217	---	---	---	---	---	---	---	---	1	217	0.39	0.58
Florida	---	---	---	---	9	1,105	1	331	2	222	12	1,658	4.69	4.45
Georgia	---	---	1	229	12	1,544	---	---	9	877	22	2,650	8.59	7.12
Louisiana	---	---	---	---	3	569	---	---	9	925	12	1,494	4.69	4.01
Mississippi	---	---	---	---	3	382	---	---	4	180	7	562	2.74	1.51
North Carolina	1	570	---	---	5	1,057	1	98	11	1,171	18	2,896	7.03	7.78
South Carolina	---	---	---	---	11	1,767	---	---	10	873	21	2,640	8.20	7.09
Texas	2	667	1	280	40	6,628	1	131	3	249	47	7,955	18.36	21.36
headquarters	9	3,038	4	1,359	26	3,502	13	2,281	9	1,151	61	11,331	23.83	30.43
Puerto Rico	---	---	1	348	---	---	---	---	---	---	1	348	0.39	0.94
Savannah Unit, Ga.	2	570	---	---	2	323	---	---	---	---	4	893	1.56	2.40
Total	17	5,649	7	2,216	127	18,716	16	2,841	89	7,815	256	37,237	100.00	100.00
Percent of Total	6.64	15.17	2.73	5.95	49.61	50.26	6.25	7.63	34.77	20.99	100.00	100.00		

TABLE XI

NCWA Larvicide, Minor & Major Drainage Work

OCTOBER 21, — NOVEMBER 17, 1945

STATE	Areas in Oper- ation	RESIDUAL SPRAYING		LARVICIDAL WORK						DRAINAGE OPERATIONS										Total Man Hours
				LARVICIDE USED		SURFACES TREATED ACRES		CLEARING		Cleaning Lin. Ft.	NEW DITCHING				Ditch Lining Lin. Ft.	Underground Drainage Lin. Ft.	Fill C. Y.	Water Surf. Eliminated Acres		
		Number Houses Sprayed	Pounds DDT Used	Oil Gals.	Paris Green Lbs.	Oiled	Dusted	Aquatic Veg. Acres	Land Veg. Acres		Hand	Lin. Ft. Mach.	Dynamite	Total Cu. Yd.						
Alabama	6	1,372	705	---	---	---	---	1	---	28,920	---	---	---	---	---	---	---	---	8,645	
Arkansas	17	---	---	---	---	---	---	78	78	30,620	11,782	---	1,296	---	---	---	---	27,385		
California	3	---	---	113	---	9	---	1	1	17,200	---	---	---	---	---	---	4	2,272		
District I	1	---	---	---	---	---	---	---	---	---	4,130	2,815	---	8,182	---	---	---	92	980	
Florida	7	---	---	837	75	18	90	2	1	5,847	1,746	---	5,652	810	150	---	---	3	6,929	
Georgia	14	2,855	2,117	117	306	8	182	7	7	16,574	668	---	66	---	---	829	---	16,526		
Louisiana	4	761	487	2,301	---	81	---	---	2	5,717	---	---	---	---	---	---	---	12,579		
Mississippi	6	---	---	100	---	4	---	9	25	52,714	---	---	---	---	---	---	---	9,784		
Missouri	2	---	---	---	---	---	---	---	1	1,170	---	---	---	---	---	---	---	9,514		
North Carolina	6	---	---	---	---	---	---	8	51	58,830	7,700	---	5,195	8,082	---	---	12	10,229		
Oklahoma	2	---	---	---	---	---	---	---	2	---	6,218	---	---	699	---	---	---	7,479		
Puerto Rico	7	---	---	925	4,115	52	2,443	1	4	67,589	2,600	---	192	---	---	---	---	22,494		
South Carolina	8	62	29	---	---	---	---	19	5	200,125	1,447	---	368	---	---	---	1	16,826		
Tennessee	2	---	---	---	---	---	---	---	1	6,745	2,967	---	225	773	946	---	543	10	7,945	
Texas	11	6,884	2,416	2,670	---	77	---	31	6	33,500	4,803	---	1,057	---	---	208	4	43,016		
Virginia	3	---	---	165	2	2	2	---	16	15,810	9,772	---	1,306	584	---	600	---	10,155		
TOTAL	99	11,934	5,754	7,228	4,498	251	2,717	157	200	541,429	53,833	2,815	11,072	22,831	1,680	---	2,180	126	212,758	
TOTAL 9-23 — 10-20	183	56,879	31,740	155,960	19,675	7,363	11,313	258	183	1,146,538	51,466	650	3,975	18,172	2,574	356	10,938	21	397,523	

TABLE XII

NCWA Personnel on Duty and Total Payroll

NOVEMBER 1945

STATE	COMMISSIONED		PROF. & SCI.		SUB-PROF. (1)		C. A. F.		CUSTODIAL AND PER HOUR		TOTAL		PERCENT OF TOTAL	
	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY
Alabama	4	1,244	1	238	17	3,047	3	463	33	4,244	58	9,236	2.42	2.34
Arkansas	11	3,773	5	1,419	30	5,206	27	3,537	140	19,965	203	32,900	8.49	8.33
California	5	1,382	---	---	4	790	2	325	10	1,120	21	3,617	0.88	0.92
District of Columbia	1	332	---	---	---	---	---	---	---	---	1	332	0.04	0.08
Florida	8	2,357	5	1,474	66	12,390	10	1,536	31	4,867	120	22,624	5.02	5.73
Georgia	11	3,465	4	934	60	10,155	7	1,041	56	7,154	138	22,749	5.77	5.76
Illinois	2	958	---	---	---	---	1	88	---	---	3	1,046	0.13	0.26
Indiana	1	284	---	---	1	360	---	---	4	976	6	1,620	0.25	0.41
Kansas	---	---	1	178	---	---	---	---	---	---	1	178	0.04	0.05
Kentucky	4	1,183	1	246	3	1,268	4	608	6	1,382	18	4,687	0.75	1.19
Louisiana	8	2,459	3	865	38	7,152	7	1,307	56	8,500	112	20,283	4.68	5.14
Maryland	1	248	---	---	1	272	1	178	---	71	3	769	0.13	0.19
Mississippi	11	3,305	5	1,321	26	4,199	8	1,275	31	4,378	81	14,478	3.39	3.67
Missouri	2	548	1	229	8	2,757	2	538	36	5,603	49	9,875	2.05	2.45
North Carolina	5	1,479	4	1,232	5	1,108	5	667	68	11,557	87	16,043	3.64	4.06
Oklahoma	4	1,210	1	246	16	2,896	2	285	38	7,309	81	11,946	3.39	3.02
Oregon	---	---	---	---	1	195	---	---	---	---	1	195	0.04	0.05
South Carolina	8	2,624	6	1,519	40	7,442	12	1,750	121	17,997	187	31,332	7.82	7.93
Tennessee	4	1,164	2	577	14	2,394	4	679	38	5,022	62	9,836	2.59	2.49
Texas	8	2,395	4	1,502	40	9,482	12	2,100	137	23,606	201	39,085	8.40	9.90
Virginia	1	332	2	645	10	1,780	2	408	61	8,409	76	11,574	3.18	2.93
<i>Aedes aegypti</i>														
Alabama	1	284	---	---	4	603	1	148	---	---	6	1,035	0.25	0.26
Florida	---	---	---	---	24	3,738	---	---	---	---	24	3,738	1.00	0.95
Georgia	---	---	---	---	6	1,047	---	---	---	---	6	1,047	0.25	0.26
Louisiana	1	284	---	---	8	1,331	1	151	---	---	10	1,766	0.42	0.45
South Carolina	1	284	---	---	5	825	1	148	---	---	7	1,257	0.29	0.32
Texas	2	567	---	---	20	3,993	2	272	---	144	24	4,976	1.00	1.26
Hq. & District (2)	92	31,642	26	5,412	68	10,212	219	35,223	74	9,668	479	92,157	20.02	23.34
Puerto Rico	7	2,027	1	297	7	1,331	5	1,079	273	12,970	293	17,704	12.25	4.48
Honolulu T. H.	4	1,299	---	---	27	5,172	2	366	1	189	34	7,026	1.42	1.78
Total	207	67,129	72	18,334	549	101,145	330	53,172	1,234	155,131	2,392	394,911	100.00	100.00
Percent of Total	8.65	17.00	3.01	4.64	22.95	25.61	13.80	13.47	51.59	39.28	100.00	100.00		

(1) Includes Entomological Inspectors.

(2) Includes Headquarters and District Offices, Mobile Units, Malaria Survey, Imported Malaria Control, Special Investigations and employees temporarily attached to Headquarters pending assignment to states.

TABLE XIII
MCWA Expenditures and Liquidations by Major Items
NOVEMBER 1945

	CONTINENTAL U. S.	PERCENTAGE OF TOTAL	PUERTO RICO	PERCENTAGE OF TOTAL
01 Personal Services	\$370,178.69	49.33	\$17,704.26	88.65
02 Travel	30,841.61	4.11	44.23	0.22
03 Transportation of Things	5,097.40	0.68	---	---
04 Communication Services	1,858.07	0.25	95.51	0.48
05 Rent and Utility Service	5,160.83	0.69	---	---
06 Printing and Binding	565.82	0.07	---	---
07 Other Contractual Service	14,365.85	1.91	1.00	0.01
08 Supplies and Materials	275,282.68	36.68	2,105.55	10.54
09 Equipment	47,124.32	6.28	20.63	0.10
10 Land and Structures	---	---	---	---
TOTAL	\$750,475.27	100.00	19,971.18	100.00
Expenditures Other Than Personal Services	\$380,296.58	50.67	2,266.92	11.35

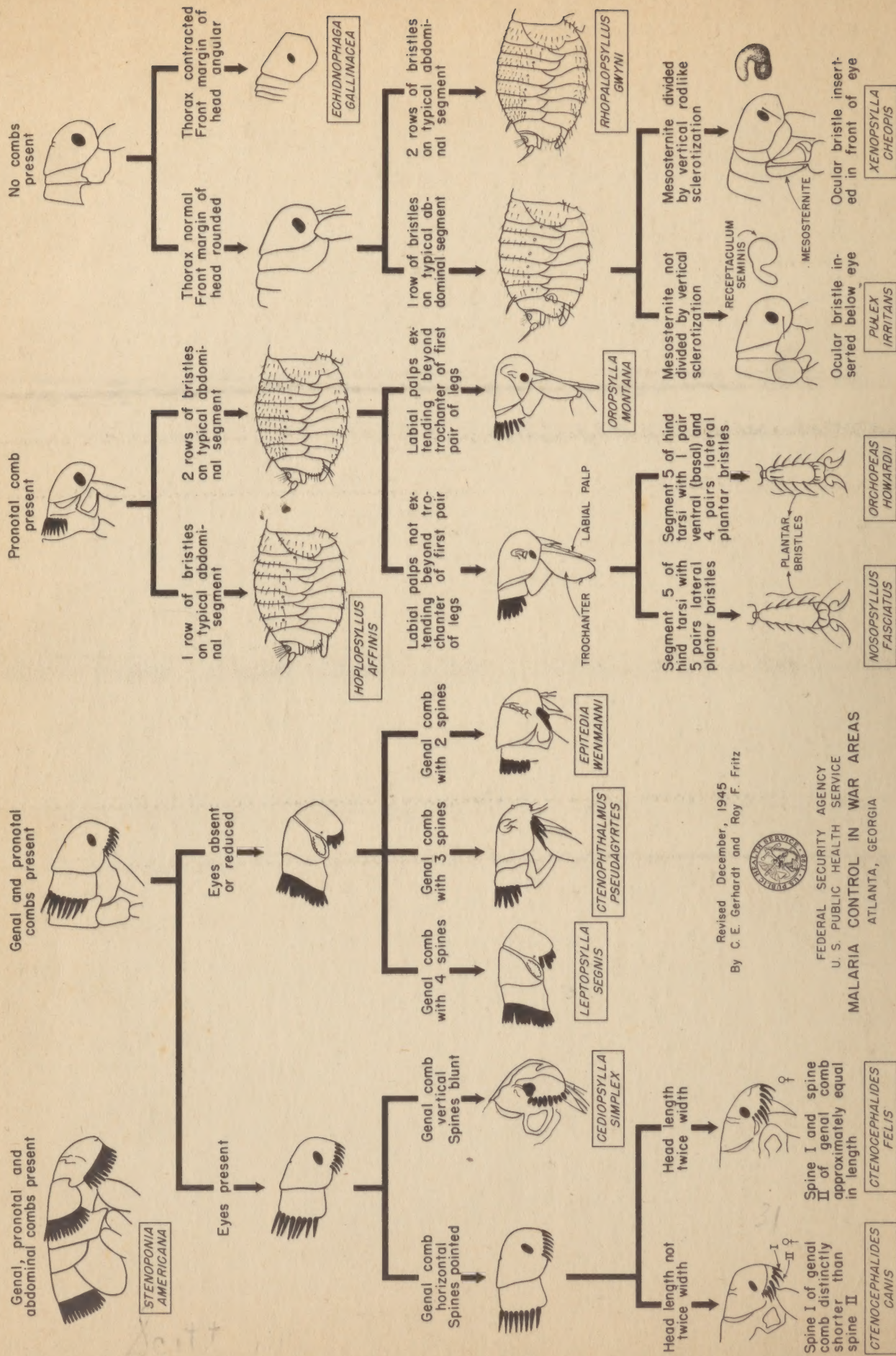
TABLE XIV
Typhus Expenditures and Liquidations by Major Items
NOVEMBER 1945

	CONTINENTAL U. S.	PERCENTAGE OF TOTAL	PUERTO RICO	PERCENTAGE OF TOTAL
01 Personal Services	\$42,310.01	90.88	\$173.84	100.00
02 Travel	---	---	---	---
03 Transportation of Things	1,000.00	2.15	---	---
04 Communication Services	.28	0.00	---	---
05 Rent and Utility Service	7.35	0.01	---	---
06 Printing and Binding	---	---	---	---
07 Contractual Service	189.34	0.41	---	---
08 Supplies and Material	724.83	1.56	---	---
09 Equipment	2,322.55	4.99	---	---
TOTAL	\$46,554.36	100.00	\$173.84	100.00
Expenses Other Than Personal Services	\$ 4,244.35	9.12		

TABLE XV
Typhus Control Personnel on Duty and Total Payroll
NOVEMBER 1945

AREA	COMMISSIONED		PROF. & SCI.		SUB-PROF.		C. A. F.		CUSTODIAL AND PER HOUR		TOTAL		PERCENT OF TOTAL	
	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY	NO.	PAY
Alabama	1	284	---	---	10	1,347	---	---	15	1,533	26	3,164	9.77	7.45
Arkansas	1	300	---	---	9	1,230	---	---	20	2,112	30	3,642	11.28	8.57
California	1	216	---	---	---	---	---	---	---	---	1	216	0.38	0.51
Florida	---	---	---	---	13	1,117	---	165	4	1,028	17	2,310	6.39	5.44
Georgia	---	---	1	229	12	2,256	2	256	9	960	24	3,701	9.02	8.71
Louisiana	---	---	---	---	3	532	---	---	4	665	7	1,197	2.63	2.82
Mississippi	---	---	---	---	4	633	---	---	---	199	4	832	1.50	1.96
North Carolina	1	284	---	---	7	1,686	1	134	10	1,108	19	3,212	7.14	7.56
South Carolina	---	---	---	---	11	1,997	---	---	11	1,112	22	3,109	8.27	7.32
Texas	---	299	---	---	62	9,263	1	131	14	1,080	77	10,773	28.95	25.36
Tennessee	---	---	---	---	2	105	---	---	4	109	6	214	2.26	0.50
Virginia	---	---	---	---	1	89	---	---	---	---	1	89	0.38	0.21
Headquarters	10	3,508	---	775	16	3,054	1	932	1	692	28	8,961	10.53	21.09
Puerto Rico	---	---	---	174	---	---	---	---	---	---	---	174	---	0.41
Savannah Unit, Ga.	2	567	---	---	2	323	---	---	---	---	4	890	1.50	2.09
Total	16	5,458	1	1,178	152	23,632	5	1,618	92	10,598	266	42,484	100.00	100.00
Percent of Total	5.01	12.85	0.38	2.77	57.14	55.62	1.88	3.81	34.59	24.95	100.00	100.00		

PICTORIAL KEY TO FLEAS FOUND ON DOMESTIC RATS IN THE UNITED STATES



Revised December, 1945
 By C. E. Gerhardt and Roy F. Fritz



FEDERAL BUREAU OF INVESTIGATION
 U. S. DEPARTMENT OF JUSTICE
 MALARIA CONTROL IN WAR AREAS
 ATLANTA, GEORGIA